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Tímea Mátyus–Natália Dankovics–Károlyné Pelyvás: Diagnostic Study of Reading Ability and Competence in Aphasic Patients
Alkalmazott Nyelvtudomány, XVII. évfolyam, 2017/2. szám
doi:http://dx.doi.org/10.18460/ANY.2017.2.009

Diagnostic Study of Reading Ability and Competence in Aphasic Patients

Afáziának nevezzük a nyelvi képesség struktúrájának azon szerzett zavarait, melyek a nyelvi működéshez kapcsolódó agyi területek sérülése következtében jelentkeznek (Kirshner, 1995; Hegyi 2011; Osmanné, 2007; Bánréti, 2014). Bár a zavar eltérő deficitmintázatokat létrehozva megjelenhet a beszélt és az írott nyelvben egyaránt (Osmanné, 2007; Obregón, 2008; Gósy, 2005; Bánréti, 2014), az olvasási készség vizsgálata és terápiája máig a háttérbe szorult. Magyar nyelven az egyetlen elérhető olvasást vizsgáló eljárás a Western Aphasia Battery (WAB) egyik szubtesztje (Szabó, 2017), ennek használata során azonban több ponton is nehézségek tapasztalhatók.
Célunk egy új, magyar nyelvű, olvasást vizsgáló eljárás kidolgozása volt, mely Ellis és Young szófelismerési modelljének elméletére támaszkodik (Ellis, 1993).
Első vizsgálatai eredményeink igazolják, hogy módszerünk alkalmas az egyes olvasási utakon nyújtott teljesítmények mérésére, megfelelő támpontot adva ezzel a terápiás folyamathoz.

1. Introduction

Aphasia is an acquired disorder of previously intact language ability which can affect oral and written languages or both (Osmanné, 1997; Obregón, 2008; Gósy, 2005; Swanberg et al., 2007; Beeson, 2004; Hillis, 2007), but does not affect intelligence (Krischner, 1995; Gósy, 2005; Hegyi, 2011; Osmanné, 1997; 2007; Bánréti, 2014). The disorder may have an effect on various modalities of language, including verbal range of expression, understanding, reading and writing (Ripamonti et al., 2017; Osmanné, 1997). In addition, dysarthria, apraxia, swallowing disorders and psychological impairment can occur inherently.

The symptoms of aphasia vary between individuals, directly after an injury in the acute period some patients are unable to communicate in any form but this state usually significantly improves with time (Baharev, 2005). Further on, grammatical and phonological errors occur in the language production (Osmanné, 1997).

Aphasic patients often produce paraphasias (substitutions) and neologisms (newly made-up words) (Ahlsén, 2006). When their language contains only these expressions this relates to jargon aphasic symptoms (Osmanné, 1997). The most common aphasia symptom in speech production is word finding difficulty which can affect the whole vocabulary of the individual or certain semantic categories (Ahlsén, 2006).

In this article we are going to focus on the disruptions of previously evolved reading skill.

This disorder which is referred to as ‘acquired dyslexia’ (Osmanné, 1997; Ellis, 2004; Gósy, 2005) or 'alexia' (Cherney, 2004; Hillis, 2007; Beeson–Rapcsak, 2006) is most commonly caused by brain injuries. This phenomenon has been researched since the end of the 19th century when scientists attempted to break the process of reading into a number of components, and match these individually by focal brain lesions. This idea is called 'the theory of localisation' (Poeppel–Hickok, 2004)

Most researches on acquired dyslexia have been carried out by cognitive neuropsychologists since the 1970's.

> When cognitive neuropsychologists investigate acquired dyslexia, their approach is not so much to ask which part of the brain is damaged in which form of reading disorder, but to ask which parts of the normal reading process have been damaged or lost. That is, they seek to explain different patterns of reading breakdown by reference to models of the normal, skilled reading process. (Ellis, 2004: 59-60)

The primary aim of these examinations is to explain the various types of dyslexias by determining the impaired and more-or-less intact functions crucial for successful reading process. An example of this theoretical approach is presented in Figure 1 below by Ellis who summarised and simplified the previous models. Since researchers have been focusing mainly on single word reading, these models are more truly called models of word recognition (Huck et al., 2017).

In Ellis' model the first module of the written word recognition process is the visual analysis system. The outputs of this module are abstract letter identities, which means the reader can distinguish letters but ignore different letter shapes (for example a=A=*A*=**A** etc.) (Ellis, 2004). The visual analysis system locates the position of each letter in a word, which makes it possible to distinguish words consisting of same letters. The visual analysis system works whether the stimuli is an existing word or nonword.

The letter strings are identified as a known word in the visual input lexicon. This is a mental dictionary which stores all the graphic representations known by the individual. As the nonwords do not have graphic representations in the

visual input lexicon, their reading is taking longer than content words (McClelland–Rummelhart, 1981).

From the visual input lexicon the words can get their meanings in the semantic system. This system stores all information about known words and is likely to be the same system used for the understanding of written and heard words. The meaning of a word is adjusted to the context at this level.

A proof of connection between the visual input lexicon and the semantic system is a faster reading of words that appear more frequently in a text as these words' meanings are already activated. According to previous observations it is also easier to process concrete meaning words than abstract words (Whitworth et al., 2014; Ellis, 2004).

All information is available from a content word in a semantic lexicon except the pronunciation. This task is carried out by the speech output lexicon.

The process explained above is called 'semantic reading process'. Skilled readers use this route when they read coherent text and this is what makes accentuation possible when reading out loud. The meaning of the words are activated in the semantic system before the speech output patterns become available.

A direct connection is also possible though between the visual input lexicon and the speech output lexicon. It creates a direct association amongst known words and the speech output lexicon without the information about meanings. Normally, we follow this reading route when for example, we have to read a string of words as fast as possible. The existence of this route has been proven by patients with brain injuries who are able to read out words but do not understand what they have read (Ellis, 2004).

Once the reader gets access to the speech output patterns, these patterns arrive into the phoneme level module in a form of phoneme strings. At the phoneme level these strings need to be transformed into articulation movements. To carry out this task, we must assume that there is a short term memory module where phonemes are stored between the time of evocation and pronunciation (Ellis, 2004). Eye tracking studies support the hypothesis which found that the eye is always ahead of the articulated word and the difference between the fixated and the pronounced units is the eye-voice interval (Levin, 1979).

The two reading routes described above were used when the stimuli had a concrete and known meaning. In cases where the meaning of the word is unknown the visual input goes straight from the visual analysis system to the phoneme level. This system identifies the individual letters and their positions whilst the representations of the phoneme level are individual voice segments - both independent from the fact that the letters and sounds can appear as segments of content words as well. The connection between these modules allow the letters and letter connections to activate the voice representation that is

common in a specific language. The process of grapheme-phoneme conversion also involves the knowledge of pronouncing certain letter combinations (for example 'ph' letter combination). This reading route is usually used only in short segments by skilled readers but it is not impossible to read solely using this route as it can be observed in many acquired dyslexic patients. This mode of reading is called the sublexical route (Ellis, 2004).

Regardless of the applied reading route, there are some other significant factors affecting the ease or difficulty of single word recognition such as familiarity, frequency, age of acquisition, repetition, meaning and context, spelling-sound regularity and interactions (Ellis, 1993), but due to a small number of studies carried out investigating these modules I am avoiding further references.

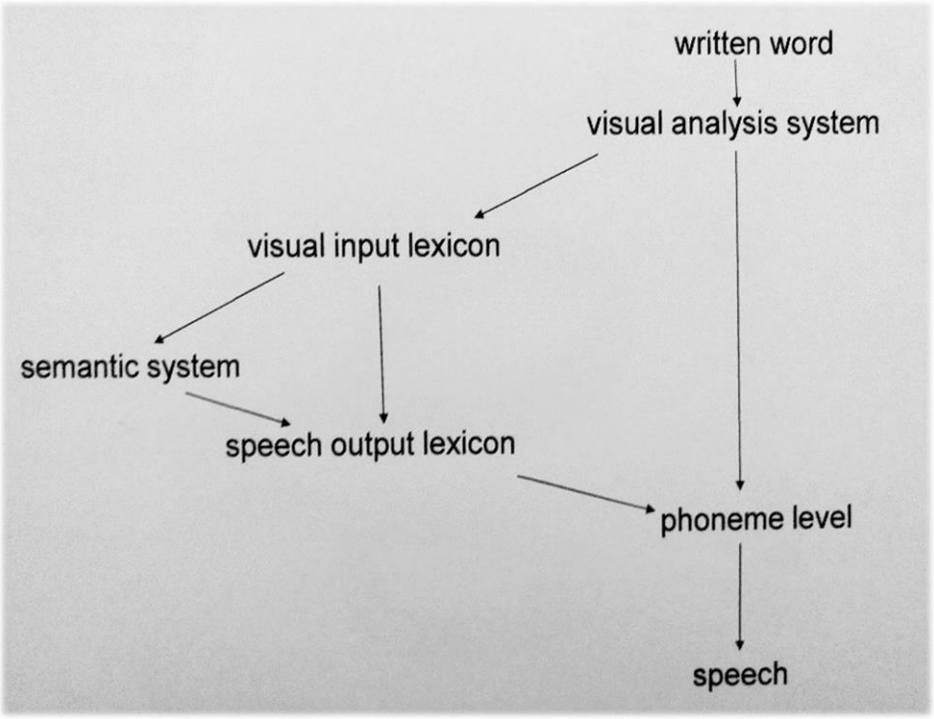

Figure 1. Simple functional model of some of the cognitive processes involved in recognising single written words by Ellis (Ellis, 1993)

Each module in Figure 1 can be impaired in different ways in aphasia causing disturbance in the reading process. Depending on the type of disturbance we can distinguish the acquired dyslexias.

If the visual analysis system gets damaged the perception of the letters in words become impaired. In this case we are talking about peripheral dyslexias. Neglect dyslexia, attentional dyslexia and letter-by-letter reading also belong to the peripheral dyslexias.

In the case of neglect dyslexia the reader makes mistakes at the beginning or the end of the word. These miscues are not simple deletions, but usually the results of (wrong) conjectures, with roughly the right number of letters (Ellis et

al., 1987; Whitworth et al., 2014). The patients can identify verbally spelt words and show an improvement in reading when the words are written vertically from top to bottom (Whitworth et al., 2014).

A rare case of acquired dyslexia is the attentional dyslexia which features an intact isolated letter and/or word reading, but with the growing number of letters/words on a page the number of miscues increase (Whitworth et al., 2014; Ellis, 2004).

Letter-by-letter readers can identify individual letters and pronounce their names (not the phonemes they mark) and most times they manage to articulate the target words, although the process is time-consuming (Whitworth et al., 2014).

In central dyslexias the damage is beyond the visual analysis system. Comprehension and/or pronunciation of written words is impaired. Non-semantic reading, surface dyslexia, phonological dyslexia and deep dyslexia belong to this group (Shallice–Warrington, 1980).

Notwithstanding non-semantic readers are able to read words and nonwords, but do not have access to the semantic lexicon therefore they cannot understand what they read.

Surface dyslexic patients are using the sublexical reading route: they read every word (including known words) with a grapheme-phoneme conversion hence they make less mistakes when words are spelled regularly. Their miscues are typically due to regularisations (Whitworth et al., 2014; Beeson–Rapcsak, 2006; Ahlsén, 2006; Patterson et al., 1985). Surface dyslexia is common in certain neurodegenerative syndromes where the lexical-semantic system damages are pronounced such as in Alzheimer's disease and semantic dementia (Beeson–Rapcsak, 2006; Friedman et al., 1993; Patterson–Hodges, 1992).

Phonological dyslexic patients have the greatest success in word reading. Whether the target word is a content word or a nonword the patient is always reading an existing word. The dyslexia is caused by the disturbance of the sublexical reading route, and the word-level reading goes through the semantic system. Therefore, the success of the word reading is dependent on a number of factors such as the concreteness of the target word (reading abstract words is usually harder), the word-class (nouns are the easiest, functors are the most difficult) and the frequency of the word, but the word-length does not affect their performance (Whitworth et al., 2014; Beeson–Rapcsak, 2006; Ellis, 2004; Osmanné, 1997).

The most common group of acquired dyslexias is deep dyslexia. In this case, patients' reading is similar to the phonological dyslexic patients' but they also make a vast amount of semantic errors. These symptoms suggest the collective impairment of the sublexical and the semantical reading routes (Hillis–Caramazza, 1990; Whitworth et al., 2014). The regularisation errors in nonword

reading infer to a fault on the sublexical phoneme-grapheme conversion (Ellis, 2004; Osmanné, 1997).

According to some, phonological dyslexia and deep dyslexia are the variants of the same syndrome (although in the past they were discussed as two completely different syndromes), in one word the difference between them is not qualitative but quantitative (Beeson & Rapcsak, 2006).

Even though the classification of acquired dyslexias have long been described and there are a few assessment methods available in English (see: LaPointe & Horner, 1998; MacGinitine et al., 2000; Woodcock, 1998; Brown et al., 1993; Kay et al., 1992; Goodman–Caramazza, 1986; Wiederholt–Bryant, 2001; Kertesz, 1982; Goodglass et al., 2000), there are just a few tests in use in languages with a shallow orthography and there is only one assessment tool in Hungarian for measuring the reading skills and it is a part of the Western Aphasia Battery (Kertesz, 1982; Web 1.; Szabó, 2017). However, this method does not enable unambiguous interpretation at several points as the scoring method is not always clear, and the results do not mirror the patient's performance that had been previously observed, or may have too few items on some tasks, or may be insufficient to detect milder problems. The general concept of aphasia treatment is providing individualised therapy to address the specific areas of need identified during assessment as well as the specific goals identified by the person with aphasia and their family. However, speech and language remedial therapy programs are usually focused on the oral language rather than written language (Hillis, 2007), even though the latter is vital for numerous everyday activities. This is why Hillis (2007) suggests that in cases of suspected stroke the assessment of the reading process should be an essential component of a complete neurological examination. He proposes the use of a detailed assessment to delineate the precise areas of breakdown and identify the spared processing components so that an effective personalised treatment program can be developed.

2. The Aims of the Present Study

Our aims are to investigate the reading process in aphasia based on Ellis' theory of single word reading process (see Figure 1), and to create a new assessment method for measuring the reading skills in Hungarian that is suitable to use in measuring the performance on different reading routes, gives a guidance to designing a treatment approach, is easy to use, and does not overload the patients.

3. Methods and Participants

Eight non-fluent patients with aphasia (6 women, 2 men; aged between 53-78) who had both motor and sensory disturbance with motor having dominance participated in our pilot study. We have measured their reading performance using the Reading Subtest of the Western Aphasia Battery (WAB)(Kertesz, 1982; Web 1.; Szabó, 2017) - the only available reading test for acquired dyslexia in Hungarian - and compared the results with the Háromutas Olvasásvizsgáló Teszt's (HOT, "Three-route Reading Test") results.

The testing took place in the Fővárosi Önkormányzat Egyesített Szent István és Szent László Kórház és Rendelőintézet Rehabilitációs Centruma where the patients were being treated for aphasia. The patients and their families acknowledged the purpose and further use of this assessment. This study was made with the patients' and their families' permission.

The first measurement was taken with the WAB followed by at least a fifteen minutes break. Secondly, we carried out the HOT testing. In the measurement process we were adapting to the mood and capacity of the patients while varying the order of the tasks and having extra breaks as required.

3.1 The Methods

Both methods are measuring the reading performance on syntaxical, lexical, and phonetical levels. We sorted all tasks into three groups according to the three reading routes described above.

The structure of the methods is presented in Figure 2. The charts suggest that whilst the WAB has a clear balance of the items measuring the three reading routes, the HOT has an enormous imbalance in the rate of the items. The purpose of disproportion was to further investigate the functionality of the sublexical reading, since this is the most commonly affected according to the outcomes of previous studies (see Whitworth et al., 2014; Beeson–Rapcsak, 2006; Friedman et al., 1993; Patterson–Hodges, 1992; Ellis, 2004).

However, the rate of the scores in the three reading routes shows an imbalance in the WAB, whilst the HOT's scores are pro-rated at each route. The WAB scores on the semantic reading route are much higher than on the other two routes and these are not required to be assessed if the patient's performance on the sentence level is satisfactory.

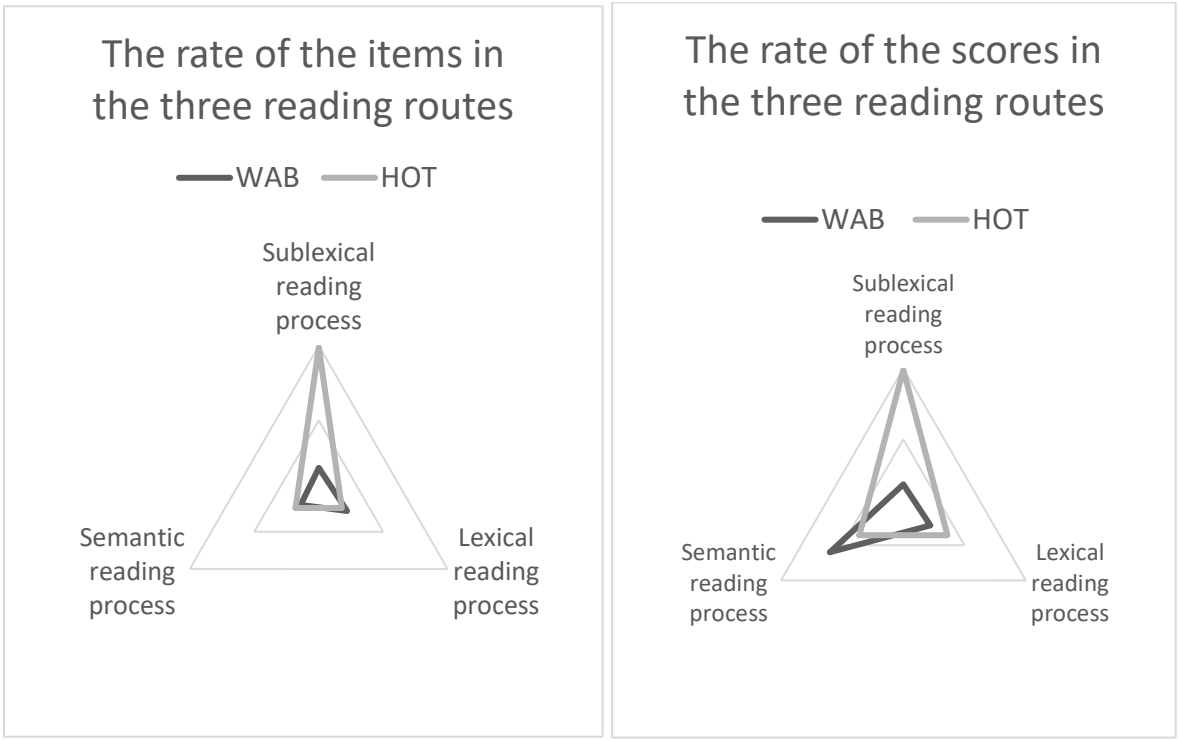

Figure 2. The Structure of Methods

We printed out both assessment tools on the same paper and laminated them. Since the reading subtest of the Western Aphasia Battery does not have any guidance about the type or size of print we used Times New Roman, size 16 letters. As the subtest is using the same objects and pictures that can be found in the verbal communication subtest, we have used the pictures which can be found in the attachment of the 'Logopédiai vizsgálatok kézikönyve' (Juhász, 2007), and our own objects. In the presentation and scoring we followed the guidelines given in Hungarian regardless of the discrepancy between the English and the Hungarian versions. Before testing we also corrected the spelling mistakes.

The Háromutas Olvasásvizsgáló Teszt tools are including printed letters, words, sentences and pictures. The letter type is Arial, the sizes are 48 on individual letters, and elsewhere they reduce to 32. The measurements of the pictures are 11cm x 7.8cm. Each stimuli is presented individually for the patients.

In the structure of the testing we were following the order of the tasks, however if a particular reading route seemed quite impaired we changed tasks to keep the patients motivated.

In the scoring we followed the guidelines provided by the WAB Hungarian version, and in the case of the HOT every answer is worth one point, the picture - word/sentence matching tasks are worth two, one for the reading and one for the matching.

3.1.1 Testing the Semantic Reading Process

Testing the semantic reading process consists of two tasks in the WAB and four tasks in the HOT. Table 1 shows the tasks measuring the reading process on the semantic reading route with examples.

Table 1. Testing the Semantic Reading Process

WAB	HOT (picture - sentence matching tasks)
Reading Comprehension of Sentences	**1 Sentence - 4 Pictures**
"The rain is... blue/wet/met/sea."	*"Pityu is drinking coffee. /Pityu is drinking wine. / Pityu is eating. /Pityu is sleeping."*
Reading Commands	**4 Sentences - 1 Picture**
"Raise your hand."	*"The fox is hunting for the rabbit. / The fox is playing with the rabbit. / The mice has chewed the sausage."*
	Picture - Proverb Matching
	"A bolt from the blue."
	Proverb - Meaning Matching
	"Suddenly something bad happens."

This is the most emphasised reading route of the WAB since after this section the testing does not have to be carried out if the patient's points are 50 or over. However, in the Hungarian version there is a note indicating that it is worth testing further to make sure the patient is not relying completely on the lexical reading route.

In the WAB's first task the patient is required to finish a sentence by choosing a correct answer amongst four options. Reading the sentences out loud is not compulsory, the patient gets points when his/her choice of card is appropriate semantically. The sentences are becoming longer in each task that requires a higher level of understanding. This is why every other task is worth two more points: the first two sentences are worth two points each, whilst the last two are worth eight.

The second task of the WAB is to read commands. This time the patient has to read them out loud and the instructions need to be carried out by the patient as well. Both the reading and the activity are worth a point each.

These two tasks are given a transformed score that can be sufficient to diagnose the dyslexia.

The first three tasks of the HOT are picture-sentence matching tasks, but the third one is different from the other two since the patient needs to match proverbs to the pictures which is a quite unusual task in comparison to reading tests in other languages. The last task in this category is a sentence-sentence matching task where the patient has to find the meaning of each proverb.

3.1.2 Testing the Lexical Reading Process

The next assessed reading route is the lexical reading process. The structure of this with examples are presented in Table 2.

Whilst the WAB seems to have more tasks linked to this reading route, it does not change its stimuli in the first three tasks. The patient needs to match objects or pictures with the same set of words. In the last task the patient has five words in front of him/her and has to pick the one that has been sounded by the therapist.

The HOT has two picture-word matching tasks investigating the lexical reading process with four answer options belonging to each of them.

Table 2. Testing the Lexical Reading Process

WAB (contains only nouns)	HOT (picture - word matching)
Written Word Stimulus - Object Choice Matching	**1 Picture - 4 Words**
"cup, comb, pencil, flower, matches, screwdriver"	*"olvas, rángat, számol, olvad" ("read, drag, calculate, melt")*
Written Word Stimulus - Picture Choice Matching	**4 Pictures - 1 Word**
"cup, comb, pencil, flower, matches, screwdriver"	*"doboz, kígyó, kosár, toboz" ("box, snake, basket, pine cone")*
Picture Stimulus - Choice Matching	
"cup, comb, pencil, flower, matches, screwdriver"	
Spoken Words - Written Word Choice Matching	
"flower, tower, tree, power, garden"	

3.1.3 Testing the Sublexical Reading Process

Table 3 shows the task belonging to the measurement of the sublexical reading process. Testing this route is expected to be the quickest task to finish with the WAB and the most time consuming with the HOT. The HOT does have more subtests belonging to this section and each task consist of more items than the WAB, however the WAB requires spelling and spelled word recognition, both very unusual and unpractised tasks for Hungarian speakers.

In HOT there are two tasks which we added to this section, but do not particularly belong here. These tasks are the reading of jumbled up words, and oral reading of single words (with no picture aid).

Table 3. Testing the Sublexical Reading Process

WAB	HOT
Letter Discrimination	**Letter Discrimination**
"J - F - B - K - M - D"	out of 24 letters
Spelled Word Recognition	**Letter Naming**
"jó, víz, szem, barna, hagyma, testvér"	presenting the 24 letters singly
Spelling	**Oral Reading of Nonwords**
"ha, tej, pénz, lány, testvér, tisztviselő"	*"ped, amon, anyavi, telisbenge..."*
	Oral Reading of Jumbled Up Words
	"tédev, hedegül, csolokádé..." (the original words would be: *"téved, hegedül, csokoládé"*)
	Oral Reading of Single Words
	"rúg, álom, részvétel, iskolatárs, étkezőkocsi..." ("kick, dream, participation, schoolfellow, dining car")

4. Results - The Performance of the Patients

Figure 3 shows every patient's performance on each reading routes measured with both methods, however the individual differences are clear and all patients' performance are pathological. In these tasks a one hundred percent performance is required.

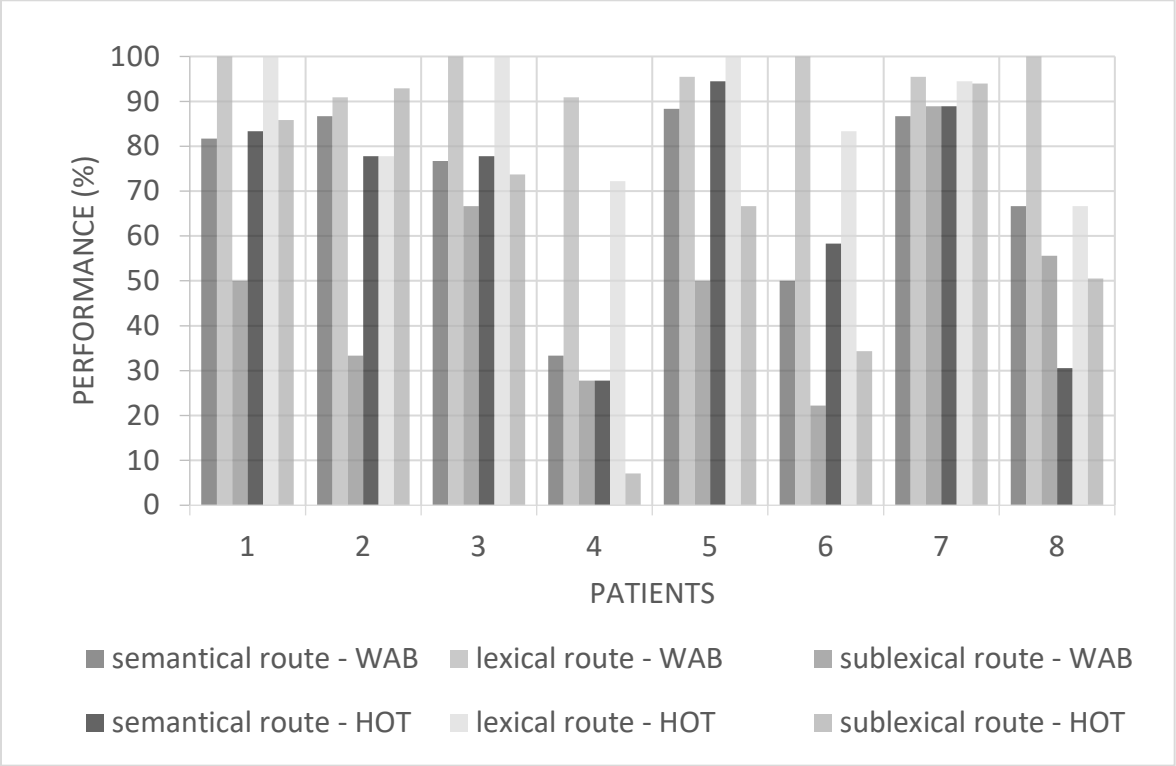

Figure 3. Summary of the Patients' Performances with Both Methods

Testing the same patient took about the same time with the two assessments (20-90 mins). Although in three cases (patient no. 2, 5 and 7) it would have been enough to examine the semantical reading route. According to our measurements, these three patients' results in the Sublexical Reading Route clearly show impairment in two cases. This proves that the whole WAB reading test should be carried out to get accurate results.

The final outcomes were similar in both tests with most patients, but the HOT provided more detailed information about the patients' reading abilities. According to the WAB results the most intact reading route in all patients is the lexical one followed by the semantic reading route. The most impaired reading strategy is the sublexical one. According to the HOT results seven patients used the lexical reading route most, and one used the sublexical one. In the final results the priority order of the applied routes were matching in the two assessments in five cases (patient no. 3, 4, 5, 6 and 7).

The overall difficulty of the tasks in both methods is summarised in Table 4, 5, and 6. For the ease of comparison we converted the points into percentages in both measurements.

4.1 Measuring the Semantic Reading Process

In the measurement of the Semantic Reading Process with the WAB the most difficult task seemed to be the Comprehension of Sentences. Although the patients scored lower in the Reading Commands task, they did not have much doubts about what to do, whilst the Comprehension of Sentences task was not always clear for them.

> *The Titanic was an oceanliner which was thought to be unsinkable but it hit an iceberg and sank in 1912, killing over a thousand people. It would not have sunk if it had not...*
>
> *lost power/ been badly damaged/ carried passengers/ been going west* (Kertesz, 1982)

It was not easy to score the patients' answers either, because of the lack of guidance for this task. In some cases, the patients were able to read out loud the sentences and the answer options, and could successfully explain which are the possible answers, but at the end they chose incorrectly, whilst others could guess right without being able to read or describe anything.

None of the patients read out loud all the sentences in the first task. We made it optional, since the guidance of the task did not make it clear.

In the HOT the hardest task in the assessment of the Semantic Reading Process for the patients seemed to be the Proverb - Meaning task. In this case, patients could not rely on their picture - noun matching skill which was intact in most cases. Table 4 shows the results in each task referring to the examination of the semantic reading process.

Table 4. Performance on the Semantic Reading Route

WAB	**71.25%**	**HOT**	**67.36%**
Reading Comprehension of Sentences	78.13%	1 Sentence - 4 Pictures	71.86%
Reading Commands	57.5%	4 Sentences - 1 Picture	71.86%
		Picture - Proverb Matching	81.25%
		Proverb - Meaning Matching	46.25%

4.2 Measuring the Lexical Reading Process

The patients' summarised performance in the Lexical Reading Process tasks can be seen in Table 5. Since the Western Aphasia Battery does not include any stimuli in the first three tasks other than six nouns all patients could solve these easily. Everyone reached a one hundred percent result in these tasks whilst they made mistakes in similar tasks in the HOT.

The only challenge was the last task, the Written Word - Spoken Word Matching. The patients made both phonological ("*toboz-doboz*") and semantic errors ("*kéz-ujj*"; "*hand-finger*").

The sample of this study was too small to make any further deductions.

In the Háromutas Olvasásvizsgáló Teszt some patients tried to read the words out loud by first referring to the pictures ("*koros-szegény*", "*old-poor*"). Phonological ("*király-sirály*") and semantic errors ("*olvas-számol*", "*read-calculate*") also occuredco.

Table 5. Performance on the Lexical Reading Route

WAB	**96.59%**	**HOT**	**86.81%**
Written Word Stimulus - Object Choice Matching	100%	1 Picture - 4 Words	86.81%
Written Word Stimulus - Picture Choice Matching	100%	4 Pictures - 1 Word	86.81%
Picture Stimulus - Written Word Choice Matching	100%		
Spoken Words - Written Word Choice Matching	81.25%		

4.3 Measuring the Sublexical Reading Process

The results on the Sublexical Reading Route are summarised in Table 6. In the WAB and HOT Letter Discrimination Tasks the patients made similar errors. The HOT seemed harder though because the lower case letters are easier to misread, the higher number of stimuli acquires more focus in addition to the use of the short-time-memory. That is why it is not surprising that the patients performed better overall in the Letter Naming Task, than in the Letter Discrimination Task.

In the spelling and letter naming tasks we also accepted the name of the graphemes and the phonemes they marked as well.

Most patients did not complete in the Spelled Word Recognition and the Spelling task of the WAB. We suspect that this was due to the lack of routine in

these types of exercises in Hungarian, although there were some individual successes (patients no. 3 and 7).

In the further HOT tasks the reading performance was clearly measurable. The patients did not have any difficulties with understanding the instructions and were all motivated to perform their best. The longer the word was the more trouble it caused to the reader in the Single Words Reading tasks. On the other hand, they all read the words fast in the Jumbled Up Words task, but they made many regularisation errors.

Table 6. Performance on the Sublexical Reading Route

WAB	**49.31%**	**HOT**	**62.37%**
Letter Discrimination	93.75%	Letter Discrimination	72.4%
Spelled Word Recognition	33.33%	Letter Naming	79.69%
Spelling	20.83%	Reading Nonwords	41.41%
		Reading Jumbled Up Words	26.67%
		Reading Single Words	73.13%

5. Discussion and Further Suggestions

In this article we have presented an overview of acquired dyslexias, demonstrated two methods in Hungarian and given an overview of the usage of them. According to a traditional approach, therapies should be highly individualised to conform to the patient's unique combination of deficits and residual capabilities, and should be hierarchically structured (Whitworth et al., 2014; Cherney, 2004). Hence, we suggest the cognitive based rehabilitation can deliver sufficient results in the development of the various functional components of the reading process. This methodology can be used to treat all types of acquired reading disorders, even if they do not entirely match the 'classic alexia syndromes' described in the Introduction (Beeson–Rapcsak, 2006; Lott et al., 1994; Maher et al., 1998; Greenwald–Gonzalez-Rothi, 1998; Behrmann–McCleod 1995; Lott–Friedman, 1999; Friedman–Lott, 1996; 2000; Beeson, 1998; Weekes–Coltheart, 1996; Hillis, 1993; Yampolsky–Waters, 2002; Cocks et al., 2013).

We plan to carry out an assessment in a larger population and compare their results with that of a control group. We expect the control group to reach 100% accomplishment in both tests in each tasks.

To be able to successfully use these methods and increase the validity of the results, we have some further suggestions for modifications. If one decides to use the Western Aphasia Battery as a measuring tool of the reading process, we highly recommend that the therapist should clarify the instructions and the scoring methods first; increase the number of items in each task, preferably use other words than nouns as well in stimuli in the Single Word Reading task. If the oral reading is not possible one needs to give a guidance on how to measure the reading skills and possibly create some new tasks substituting the "reading aloud" tasks.

In case of preferring the use of the HOT there are not many modifications needed to be able to use the test without oral reading and they do not break the structure of the assessment method. The number of items belonging to each tasks are satisfying and involve a wider range of words.

However, in both cases measuring paragraph-and text-level reading would be desirable.

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